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U. S. ARMY

Technical Memorandum 16-63

VIGILANCE WITH BACKGROUND MUSIC

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AMCMS Code 5014.11.841

HUMAN ENGINEERING LABORATORIES

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ABSTRACT

This study draws together two sorts of work -- attempts to improve vigilance performance and use of background music in industrial settings -- to explore how background music affects performance on a vigilance task. Fourteen subjects were tested on a simple disjunctive reaction time task, which gave eight stimuli in an hour's session. The independent variable was music (a specially programmed Muzak tape recording) vs. continuous noise (a small fan in the experimental room). The performance of subjects who worked while hearing noise did not change significantly during the hour. However, the subjects who heard background music responded significantly better (faster) during the latter two-thirds of the hour than they had at first. Also, the music group performed significantly better in the middle third of the hour than during the last third. Other tests, comparing the groups with each other, rather than with themselves, did not demonstrate significant differences with the number of subjects used.

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VIGILANCE WITH BACKGROUND MUSIC

INTRODUCTION

Vigilance has become the object of many research studies. The reports and speculations about it have come to be a significant volume of literature; the Human Engineering Laboratories, for example, have published results of several vigilance experiments (3, 6, 13, 14).

Vigilance might be defined as watchkeeping performance in an unstimulating environment. While specific vigilance tasks vary from one experiment to another, ranging from watching an oscilloscope in the laboratory to watching for aircraft in the desert, these tasks have several common elements. The tasks are undemanding much of the time -- the subject has little to do. Yet, on the other hand, certain significant signals are presented from time to time, and the subject is instructed to respond to them as promptly as possible. Usually the task conditions are monotonous, in that they offer little changing stimulation or novel stimulation. These vigilance tasks are, obviously, like many tasks military personnel must perform. In fact, with increasing automation in both military and industrial spheres, the number of vigilance tasks may be expected to mushroom, requiring more and more men to monitor what machines are doing for long times, making adjustments only occasionally.

While there has been extensive study of vigilance, most of this research has dealt only with variables of the task itself -- how stimuli are presented, or how often, or the like. The environment in which subjects perform has had much less attention.

The present study examined how vigilance is affected by changing the background of stimulation in which subjects work at their vigilance tasks. Specifically, this study compared vigilance when background music was played, with vigilance when there was similarly loud random noise.

The extensive use of background music in stores, offices, and factories suggests that music must have a beneficial effect on work output and/or on morale. Experimental results have demonstrated that music can indeed increase work output. Two recent studies by Konz (9) found that college students performed much better ($p < .001$) when listening to programs of Muzak background music while comparing nonsense letters, tracking on a pursuit rotor, and doing a manual assembly task. But experimental findings have not always been successful in demonstrating such an effect. For example, although Mikol and Denny (11) found that listening to

a metronome improved rotary pursuit performance, McGehee and Gardner (10) reported that their rug setters' production was unaffected, and Dannenbaum (2) concluded that music actually made people less able to find faults in geometric figures. Kirkpatrick (8) reported that music hindered work demanding mental concentration, but Smith (12) found that it did not adversely affect output, error rate, or absenteeism. Freeman and Neidt (5) concluded that students can understand a film just as well while listening to unfamiliar background music as when listening to familiar background music. Freeburne and Fleischer (4) found that students comprehend Russian history just as well with music as without it. These results suggest that the way music affects work output may vary from one situation to another.

Much less attention has been given to the ways that changing a music program can affect performance. The frequently used phrase "effect of music on performance" suggests that investigators consider musical selections at least roughly interchangeable. While they do, of course, specify the music they have used, there is a strong presumption that results would have been about the same with any other program of music that had been selected. Actually, the relationship might be still more complex: an interaction among tasks, characteristics of the music, and individual differences.

A second distinct criterion is morale. Even if music had no direct effect on work output -- which, in this writer's opinion, has not been established -- music might still be advantageous if it improved workers' job satisfaction. For instance, McGehee and Gardner's (10) rug setters liked music and said it was beneficial, even though their production did not increase. Ease of recruitment may also be affected; Kerr (7) concluded that, other things equal, "Workers will go to job locations where they can hear music while they work."

To sum up, there has been considerable speculation, generous contributions of expert opinion, and some experimentation about music and job performance. Yet at the time the present study was planned, a literature search indicated that no one had attempted to harness whatever "magic" music has to improve vigilance performance. More recently, Buckner and McGrath (1) have published results of a study in which Navy personnel working at vigilance tasks were exposed to white noise and to a "variety" program including white noise, vocal and instrumental music, the audio part of television programs, traffic noise, and mechanical noises. In brief, the subjects were required to detect slight increases in the brightness of a blinking light. These brightness changes, occurring about 24 times each hour at random intervals, were large enough that alert men could detect them 90 percent of the time. Each subject served in a balanced series of test conditions -- eight one-hour sessions given over a period of four days. Results showed that vigilance was maintained better ($p < .001$) with the "variety" program, even after considerable practice.

The present study tested a hypothesis much like Buckner and McGrath's: that increasing the variability of environmental stimulation by introducing background music will lead to better vigilance performance. However, rather than using available commercial recordings, it used a special program of background music representative of that played in offices and industry, to allow better control of the music's suitability. Furthermore, the experimental design and statistical analysis were especially tailored to consider any learning and motivational changes which might be engendered by the experiment itself.

METHOD AND PROCEDURE

Subjects

Although a number of subjects were used in a pilot study to test the adequacy of the apparatus, this report is based on data from 14 subjects used in the experiment proper. The subjects were run by the author and students in his Industrial Psychology class.* The subjects were not a sample of any defined population, since each experimenter recruited his own subject. However, all but one of the subjects were males between the ages of 18 and 35, employed at Aberdeen Proving Ground, Md., or Edgewood Arsenal, Md.

Apparatus

The vigilance equipment was a Stoelting disjunctive reaction timer. Its stimulus was a translucent plastic piece about one inch square, which could be illuminated from behind with three colors of light -- red, green, and yellow. After the experimenter had selected the predetermined stimulus color for a trial, he presented the stimulus by pressing a lever switch that simultaneously turned a light on and started a timer. The subject responded by pressing the correct one of three telegraph keys, which turned the light off and stopped the timer. If a subject pressed the wrong key, the light did not go out, and he continued pressing keys until he had operated the correct one. The light remained on until the subject turned it off by making a correct response. The apparatus thus measured time, to the nearest hundredth of a second, between stimulus presentation and correct response; it did not allow experimenters to record incorrect responses.

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* Philip Barbre, Raymond F. Blackmer, Paul A. Fair, William B. Kahl, Eric J. Keele, Robert J. Marone, John J. McMahon, Henry C. Newman, Edward L. Nordan, Anthony J. Pinto, Patricia C. Rafferty, R. Bradley Randall, Robert T. Rhodes, and William F. Williams.

There were two sound backgrounds -- noise and music. The noise was produced by a small table fan across the room from the subject. It produced a moderate, constant noise such as psychologists often use to obscure extraneous sounds.

The music was a tape recording played on a Wollensak T-1500 tape recorder through an eight-inch loudspeaker in a wood enclosure near the fan. Because music encompasses such a wide variety of possibilities, thus becoming at least a potential variable in itself, the author felt that the program should be representative of accepted good practice that would actually be used in planning a program for this sort of task. Accordingly, the Muzak Corporation, New York City, was contacted for guidance.* The program of selections used was the first hour of a specially prepared tape (Muzak Serial No. Z-35069).

The loudness of these sounds was measured at the subject's ear position with a General Radio Type 1555-A Sound Survey Meter, which expresses sound-pressure level at the microphone in relation to the 0.0002-microbar standard reference. These measurements are given in Table 1. While it appears that the music was somewhat louder than the fan, much of the discrepancy may be due to the fact that the music measures are peak values which do not represent average level. The music and fan loudnesses were almost equal phenomenologically, since subjects had selected a comfortable, comparable music level during the pilot phase. Neither sound was as loud as the 72 decibels that Buckner and McGrath (1) used; our subjects simply did not care to listen to background sounds that loud.

TABLE 1

Sound-Pressure Levels at Subject's Ear

Sound	Loudness (decibels)		
	A-Scale	B-Scale	C-Scale
Fan	48	54	57
Muzak	54-59	57-62	62-67

* Thanks are due especially to John H. Bohlendz, formerly with Muzak Corporation, for his invaluable aid in preparing a program especially suited to the requirements of this experiment.

Procedure

The experimental design was a simple factorial plan in which half of the subjects worked with music, then noise, while the other half worked with noise, then music. Since each subject served under both conditions, this sort of arrangement made efficient use of a small number of subjects. It assured that measurements for the two conditions would be comparable, since each subject acted as his own control. In using it, however, we must assume that any transfer of training from the first condition to the second is the same as the transfer from the second to the first, and that there is no significant practice effect from one session to the next.

Subjects were assigned randomly to one of two groups, depending on which background sound they were to work with first.

Each experimenter took his subject into a small, acoustically treated experimental room and explained the task by giving standard directions that disguised the study's real purpose. The subjects who worked with music first were told:

Instructions for Vigilance Study

" The study you are going to help with today and tomorrow is a test of alertness. We want to find out how alert you can stay when you have to do a task for an hour at a time. Alertness is very important in a lot of military situations -- your life, and maybe your buddies' lives, too, can depend on how alert you are.

" The task you're to do is based on what the officer in charge of a missile site might have to do. One of his most important jobs would be keeping track of targets in his area. Let's say that the radars and computers do most of the work for him. When a target comes near, they flash a light to warn him -- a light about like the one in front of you.

" An electronic device also sends out a coded signal to identify the targets and tell whether they're friendly, enemy, or unidentified. The color of the light tells you what the target's identification is -- (give card to subject)

Green - Friendly	3
Yellow - Unidentified	1
Red - Enemy	2

Then you press a key to tell the missile system what to do. Here are your orders for the day:

TABLE 2

Schedules for Stimulus Presentation

Trial	Time (minutes from start)	Color of Light	Response Key
		First Hour	
1	2	Green	3
2	5	Red	2
3	13	Green	3
4	27	Yellow	1
5	33	Red	2
6	41	Red	2
7	55	Yellow	1
8	58	Green	3
		Second Hour	
1	4	Yellow	1
2	9	Green	3
3	16	Yellow	1
4	24	Red	2
5	36	Green	3
6	44	Green	3
7	51	Yellow	1
8	56	Red	2

If friendly, press 3 to keep the system from
firing a missile.
If unidentified, press 1 so the computer will
try to identify it a second time.
If enemy, press 2 to track it.

"Respond quickly and accurately -- try to be fast, but be sure you make the right response. Do you have any questions? (If there are questions, answer by repeating from written instructions above, if possible.) (Demonstrate how apparatus works.)

"One more thing you might wonder about -- you'll notice that there's a loudspeaker over there (Point) in the corner. This room isn't sound-proofed -- and so you won't be distracted by people out in the hall, I'm going to play a tape while you do the task.

"All right, we're ready to start. Begin watching for the light as soon as I close the door. I'll let you know when the time is up."

Subjects who worked with the fan noise first got these same directions, except that the next-to-last paragraph was omitted. The fan was on when they entered the room, and they did not seem to question its purpose.

A subject remained at his task for one hour, during which eight stimuli were given -- rather a slow presentation rate, even as vigilance studies go. The experimenter presented stimuli as the schedule called for them, and he recorded the time his subject took to respond to each. He also observed his subject through a one-way window from time to time. At the end of the hour, the subject was excused until the next day without further explanations.

On the second day, the subject worked under the remaining noise condition. First he was asked if he had any questions, although most did not. It then seemed necessary to explain why the noise condition would be different: "We're having trouble with the tape recorder," or "We couldn't get the tape recorder to work yesterday." Although every effort was made to keep the subjects ignorant of the study's hypothesis, we must confess dissatisfaction with this subterfuge; several subjects chuckled, or grimaced, or gave us knowing looks.

Schedules for stimulus presentation are given in Table 2. All subjects had the same schedule during the first hour, regardless of condition; and all had the same schedule the second hour.

TABLE 3

Attitude Toward Music During the Experiment

Name________________

Different people feel different ways about the music that was played in part of the experiment. The statements below represent several points of view. For each statement, please mark whether you:

A - Agree with it.
D - Disagree with it.
? - Are undecided about it.

Scale Value	
5.5	The music made the task seem easier.
3.6	I'd have to work with music longer before making up my mind about it.
7.0	The music was really great.
5.6	The music made the task much easier for me by blocking out the noises from the hallway.
1.8	The music kept me from concentrating.
4.0	The music had no effect on me.
5.3	Sometimes I like to listen to music.
3.3	Hearing music really didn't bother me much.
2.3	I didn't like the tunes.
6.7	I just couldn't do my best without music.
3.8	The music wasn't too bad, but not too good, either.
4.8	Sometimes music makes my tasks easier.
2.6	Music is sometimes disconcerting.
6.1	The music helped me relax and do a good job.
1.0	I kept wishing they would turn the music off.
5.8	The music broke up the monotony and boredom.
6.4	The music is soothing to the nerves and makes you feel relaxed.
1.4	The music kept distracting me and caused me to lose concentration.

After both sessions, the experimenter had his subject take a Thurstone-type attitude scale about the music he had heard, as shown in Table 3. Each item's scale value, shown in the left column, was calculated in the usual way by averaging the ratings eight judges gave it on this scale:

7 - Very favorable
6 - Favorable
5 - Somewhat favorable
4 - Neutral
3 - Somewhat unfavorable
2 - Unfavorable
1 - Very unfavorable

An individual subject's attitude score, then, is conventionally the median scale value of the items he agrees with (ignoring the items he disagreed with or was uncertain about). Scores from the attitude test thus evaluated subjective reactions to the music, to complement the work output measures that had already been obtained. Any comments the subject volunteered about the music were recorded on the back of the attitude test.

Finally, the experimenter explained the study's purpose to his subject and asked him not to discuss it with anyone else.

RESULTS AND DISCUSSION

Because this experiment has been partly exploratory in nature, the results are presented and discussed in somewhat more detail than usual, both to explore a theoretical model and as a guide for future experimentation.

In Table 4, the data have been averaged for each of the eight trials under the two conditions. This classification is the one which had been planned, since it balances the order of conditions: half the subjects had music first, and the other half had noise first. There was a 0.14 second over-all difference between reaction-time means -- reaction times with noise were about 10 percent longer than with music -- although the differences are not statistically significant. When t was calculated from direct differences between a subject's reaction time scores on a trial under the two conditions, none of the values reached the .05 point.

One must remember, of course, that the sample reported here is small, and that one is less likely to be able to demonstrate significance with small samples. Some of the differences did seem to be creeping up on significance without quite reaching it; for example, the t for the largest difference in means (Trial 2) was 1.601, yielding a p near the .07 point. But these nonsignificant results cannot be explained entirely on the basis of a small sample. If the sample were enlarged, while maintaining the same t ratio, a value of 1.601 would not reach the .05 point even with an infinite number of subjects.

TABLE 4

Reaction Times for Noise and Music Conditions

Stimulus	Mean Reaction Times Noise	Music	Difference* (Noise minus Music)
1	1.61	1.79	-0.18
2	1.87	1.31	+0.56
3	1.39	1.50	-0.11
4	1.37	1.30	+0.07
5	1.56	1.28	+0.28
6	1.54	1.13	+0.41
7	1.40	1.18	+0.22
8	1.44	1.58	-0.14
Grand Means	1.52	1.38	+0.14

* Positive values indicate faster mean reaction time under music condition, while negative values indicate that mean reaction time was faster with noise.

Now let us attempt to check whether the statistical design's assumptions have been met. There were two assumptions: (1) that there were no progressive response changes; and (2) that transfer from the first condition to the second, was the same as from the second to the first. The data are given separately for the two orders of conditions in Table 5; and the mean reaction time curves are plotted in Figures 1 and 2.

TABLE 5

Reaction Times for Each Group, by Days and Trials

Stimulus Time (minutes after start)	Group A Mean	Group B Mean
First Hour	Music	Noise
2	1.76	1.71
5	1.11	1.51
13	1.83	1.60
27	1.19	1.56
33	1.14	1.67
41	1.10	2.01
55	1.10	1.55
58	1.77	1.48
Second Hour	Noise	Music
4	1.50	1.82
9	2.22	1.51
16	1.17	1.18
24	1.18	1.42
36	1.44	1.42
44	1.06	1.16
51	1.25	1.25
56	1.40	1.39

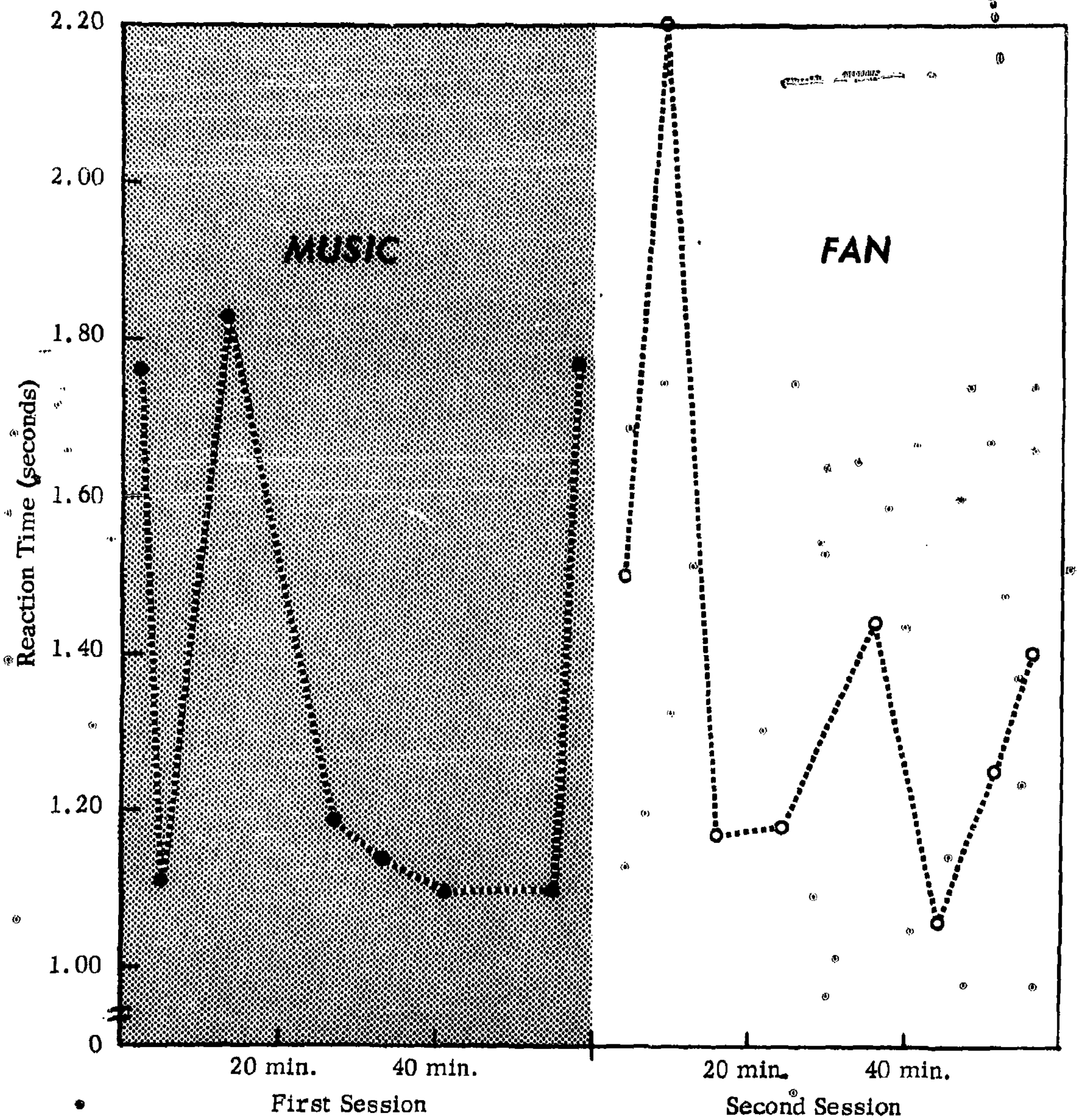

Fig. 1. MEAN REACTION TIMES FOR GROUP A, BY CONDITIONS AND TRIALS

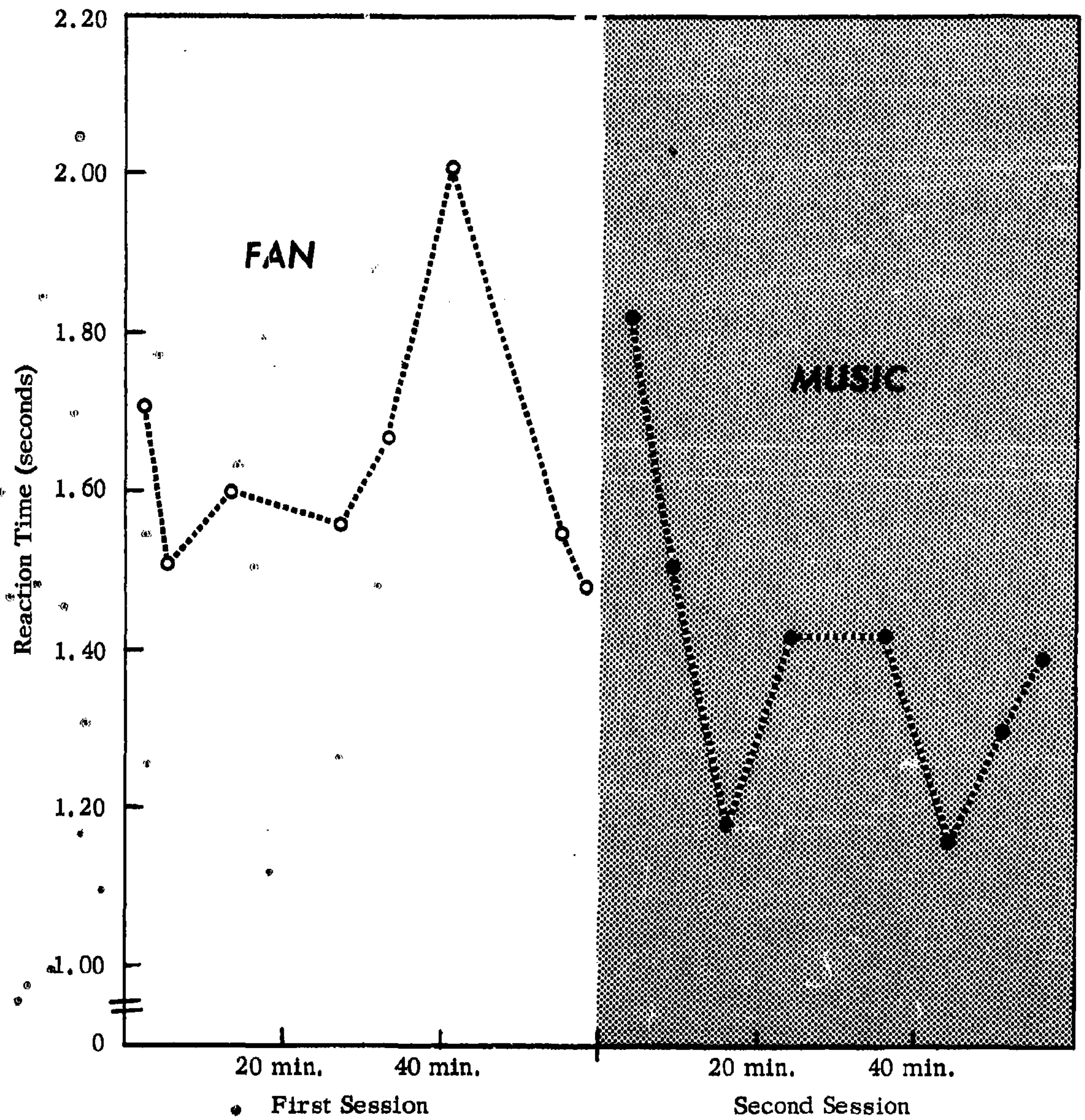

Fig. 2. MEAN REACTION TIMES FOR GROUP B, BY CONDITIONS AND TRIALS

Comparing the shapes of the two curves immediately reveals some intriguing relationships. With both groups, music seems to have yielded faster reaction times in the latter two-thirds or so of the hour. On the other hand, the two groups did not respond as consistently to noise. Most significant for the present discussion, the relative performance with music and with noise is clearly not the same for the two groups. If music was given first, average performance was roughly the same for the two conditions. But if noise was given first, average performance improved when music was given. As the following discussion will show, these facts suggest that progressive response changes during the experiment have obscured the relationship between the two conditions.

Progressive response changes may be either positive or negative. When a person continues to work at a task over a period of time, his performance may improve because of learning, or it may deteriorate because of factors such as fatigue or boredom. When task and environmental variables remain constant, these changes are comparatively simple to evaluate, since they are mirrored in the work-output curve. But where task or environmental variables have changed, any effects they produced are confounded with the progressive response changes.

Let us examine how progressive response changes might affect performance in a hypothetical situation. Suppose we have subjects work at a task on two separate days, A and B. The task might be long enough that subjects could learn a significant amount while doing it, or it might be a short task with opportunities for learning interpolated between the two test days (for example, newly hired workers who are tested on a job-related task when hired and again later). The important point here is that we test at two separate times, A and B, so that the subjects have learned more by B than they knew at A.

Even if a subject is tested under optimum conditions of motivation and environment, there will nevertheless be some maximum, best performance which is his limit on both days. Although a number of variables enter into determining this limit, the one which varies between A and B is learning. Thus, because he has learned between A and B, he will be capable of better performance under ideal conditions on Day B than he was on Day A. We will call these performance limits the subject's maximum. The solid line in Figure 3 shows a subject's maximum possible performance for the two days. As an approximate analogy, the maximum may be interpreted something like Hull's habit strength (${}_SH_R$).

But people do not always deliver the best or greatest performance they are capable of. Numerous factors can degrade their performance to some fraction of the theoretical maximum. Actual work output then, probably depends on ${}_SH_R$ interacting multiplicatively with other variables to determine performance, which is analogous to ${}_SE_R$ In the Hullian scheme, these "degradation" multipliers include such things as stimulus intensity and amount of incentive. To deal at a

more molar level, why not just assign a complex experimental condition a single, composite "degradation" multiplier? If we have two conditions, 1 and 2, Condition 1 may degrade the theoretical maximum ($_SH_R$) to an actual performance ($_SE_R$) of 80 percent, while Condition 2 degrades performance to 50 percent of the maximum. This situation is shown in Figure 3.

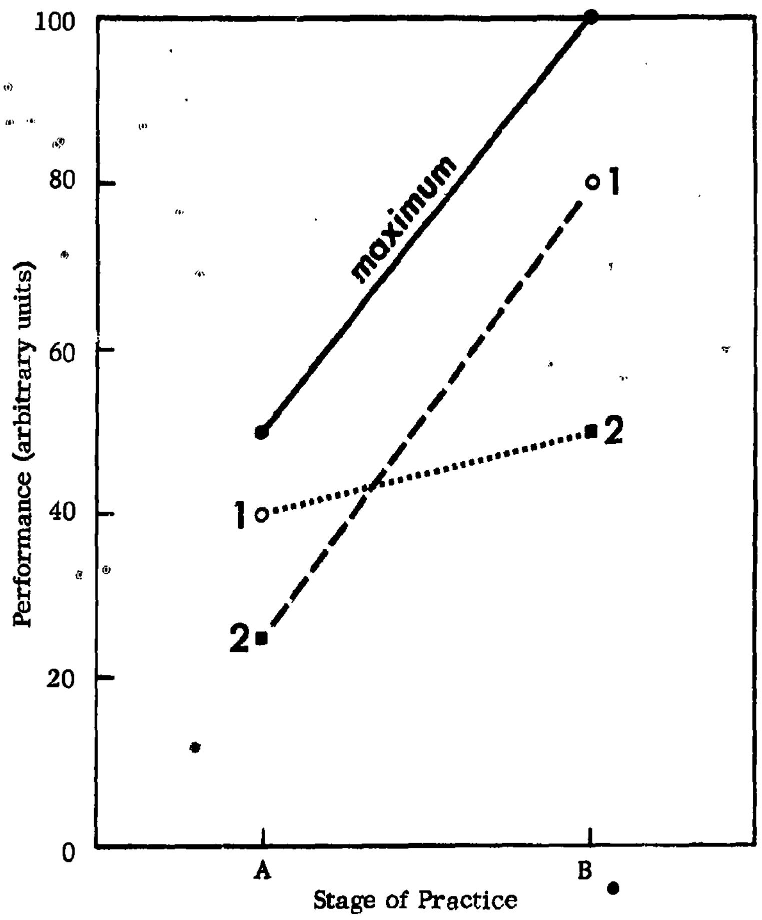

Fig. 3. THEORETICAL MODEL OF HOW WORK OUTPUT WOULD BE AFFECTED BY CONFOUNDING EXPERIMENTAL CONDITIONS AND PROGRESSIVE RESPONSE CHANGES (see text)

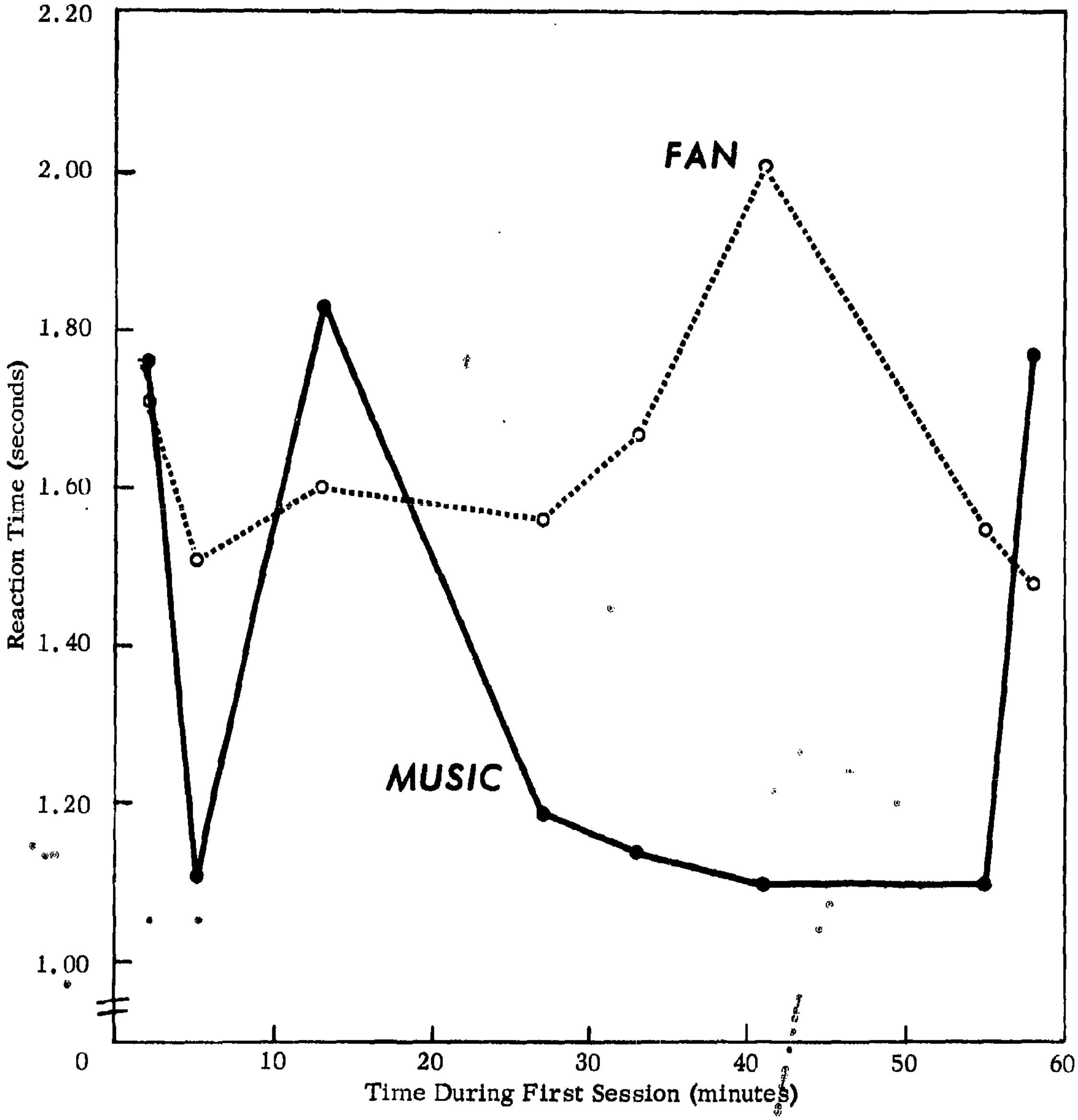

Fig. 4. MEAN REACTION TIMES FOR FIRST SESSION (INDEPENDENT GROUPS), BY CONDITIONS AND TRIALS

Figure 3 shows two dashed lines representing two groups of subjects. The first group had the two conditions in one order, and the second group had them in the other order. The plotted points show how performance at the two times would be degraded from the theoretical maximum. Note especially the relationship between the two groups' performance: one group shows very little improvement, while the other group shows considerable improvement. This relationship would be equally true if progressive response changes were negative, although the maximum would then decrease, rather than increase. As a matter of fact, it can be shown that this relationship will hold true whenever the maximum line departs from the horizontal -- in other words, whenever there is a progressive response change, whether positive or negative.

It should be possible to take advantage of these relationships, to develop statistical tests for progressive response changes. Since one group would tend to achieve scores either higher or lower than the other, the two groups should have significantly different variabilities. One of the groups' scores might have a normal or roughly normal distribution; the other distribution, really comprising two normal curves, would tend to be bimodal. The nonparametric Wald-Wolfowitz Run test should demonstrate that the number of runs is significantly fewer than expected. The Moses test of extreme reactions, another nonparametric technique, should also be applicable. Since these ideas were based partially on the data from this study, they cannot, of course, be tested on the same data; hence none of these techniques have been applied here.

This analysis supports the conclusion drawn from examining the performance curves: that the effects of conditions were confounded with those of progressive response changes.

There is good reason to believe that transfer between the conditions was also unequal, since several subjects apparently did not accept what they were told in the second day's instructions. When they were questioned later, some of them admitted that they had guessed the experiment's hypothesis and had then tried harder to show that they could do the task well under either condition. This sort of motivational change is especially pernicious, as it can produce a Hawthorne effect insidiously without being obvious enough to attract attention. In future studies, it would probably be best to use separate groups under the two conditions, matching them, if possible, to assure that they have equal ability at the task.

At any rate, it seems clear that the statistical analysis should be based on the first day's data, discarding the data from the second day. The first day's performance, already given in the top half of Table 5, is plotted in Figure 4. The subjects in the two groups should have been approximately equivalent, since they were assigned randomly. As a check, we may compare their performance on the first trial. Since the noise group had a slightly faster reaction time on this first trial, it appears that the experiment began with the cards stacked slightly against the hypothesis that music would improve vigilance.

The curve for the noise group shows a decrement in vigilance -- longer reaction times -- during the latter part of the hour. The music group, after some initial instability, seemed not only to maintain its vigilance but actually to improve. The music group, however, had a strangely long reaction time on the last trial, which is difficult to interpret; perhaps an individual selection distracted them, or perhaps they thought the last stimulus had been given.

The differences in means for individual trials have been compared using the standard Fisher t ratio for uncorrelated measures, as shown in Table 6. All are nonsignificant.

TABLE 6

Fisher t Tests Comparing Performance of Music Group and Noise Group

Trial	Noise Mean	Music Mean	Difference (Noise minus Music)	t
1	1.71	1.76	-.05	--
2	1.51	1.11	+.40	1.38
3	1.60	1.83	-.23	--
4	1.56	1.19	+.37	1.05
5	1.67	1.14	+.53	1.62
6	2.01	1.10	+.91	1.17
7	1.55	1.10	+.45	.96
8	1.48	1.77	-.29	--

Since some of the t ratios suggested that relatively large within-groups variance might be masking real differences between groups and from time to time, the stability of scores was improved by pooling the trials given close to each other. During the design phase, the stimulus times had been selected so scores could be pooled in this way. Thus the first three stimuli -- at 2, 5, and 13 minutes -- tested performance early in the hour, before a vigilance decrement would be expected. The next two stimuli -- at 27 and 33 minutes -- evaluated performance at the half-hour area, where vigilance in watching radar and sonar displays often has deteriorated seriously. The last stimuli -- at 41, 55, and 58 minutes -- revealed how vigilance was maintained during the latter part of the watch. A subject's scores in each of these three blocks were thus averaged to obtain a more reliable estimate of that subject's performance in each time span.

Table 7 gives means and standard deviations for the pooled-trial blocks, and Table 8 summarizes the results of three t tests comparing the groups' performance on each of them. As the table shows, differences between the two groups were not significant.

TABLE 7

Reaction-Time Means and Standard Deviations for Pooled-Trial Blocks

Trial Block	Mean	Standard Deviation
	Music (Group A)	
1 - 2 - 3	1.73	.69
4 - 5	1.17	.27
6 - 7 - 8	1.37	.66
	Noise (Group B)	
1 - 2 - 3	1.61	.77
4 - 5	1.62	.80
6 - 7 - 8	1.68	.97

TABLE 8

Comparisons of Music and Noise Groups' Performance on Pooled Trials

Trials Compared	Difference Between Means	t
1 - 2 - 3	-.12	.24
4 - 5	.45	1.42
6 - 7 - 8	.31	.70

Table 9, however, reveals that the groups were significantly affected by the independent variable. This analysis compares each group with itself for different times during the hour. Note first that the noise group performed at about the same level throughout. When the mean reaction times for the three blocks are compared, the means differ only slightly -- the largest difference is .071 seconds -- and none of the differences is significant.

However, the music group performed differently in the three blocks, and all of the three possible comparisons proved significantly different. Rather than showing the predicted vigilance decrement during the hour, the music group actually improved, responding significantly more quickly during the last two blocks than it had during the first one. When these latter two blocks are compared with each other, performance was significantly better during the middle block than in the last one, although both were reliably superior to the initial block. This finding supports the more general hypothesis that background music would lead to improved vigilance, yet it is intriguing to find that music did so by improving performance, rather than merely maintaining it.

TABLE 9

Performance Changes During Vigilance:
Comparisons of Performance Between Pooled Trials
for Music and Noise Groups

Pooled Trials Compared	Difference Between Means	t †
Music (Group A)		
1 - 2 - 3 vs. 4 - 5	.563	2.56*
1 - 2 - 3 vs. 6 - 7 - 8	.362	2.57*
4 - 5 vs. 6 - 7 - 8	.201	2.48*
Noise (Group B)		
1 - 2 - 3 vs. 4 - 5	.013	.09
1 - 2 - 3 vs. 6 - 7 - 8	.071	.64
4 - 5 vs. 6 - 7 - 8	.059	.35

† Computed from direct differences between paired measures.

* Significant beyond .05 level ($t_{.05} = 2.179$)

The median attitude test score for these subjects was 5.55, with a range from 5.8 to 1.8. The distribution was negatively skewed, and the lowest score appeared to be an isolated case; the second-lowest one was 3.7. Surprisingly, the median attitude score was somewhat lower in the music group (4.8) than in the noise group (5.6). Again, it appears that the laws of chance gave the noise group a slight edge over the music group. Thus the demonstrated superiority of the music group was not due to any greater preference for music. Yet perhaps this variable deserves to be explored systematically to determine whether it has any effect on work output with music.

This experiment has called attention to several points of design which are worth summarizing. It appears that it would be wise to use separate groups under these two conditions, to minimize the chances that within-groups variability will be contaminated with uneven transfer effects and extraneous progressive response changes. If possible, the groups should be matched, rather than merely randomized; if they are not, there should be some provision for evaluating their comparability. Although a small number of subjects has been useful for this factorial study, more definitive efforts should of course use larger numbers of both subjects and trials. It would probably be best to practice the subjects well before beginning to gather data, to assure that their performance will be near the asymptote. The rather crude apparatus used here could be improved in several ways. It seems desirable to use a less obvious stimulus, one which would have less attention value than a rather bright light. If possible, automatically programmed stimuli might reduce the random variation somewhat and yield more stable measures. Finally, both the nature of the music and the subjects' affective responses to music seem to deserve further study.

SUMMARY AND CONCLUSIONS

1. Fourteen subjects responded to eight light stimuli presented during a one-hour vigilance task. Half of them worked while listening to a special program of background music, while the other half heard a similarly loud fan. The dependent variable was time to make a correct response by pressing the proper one of three keys.

2. The performance of subjects who worked while hearing noise did not change significantly during the hour. However, the subjects who heard background music responded significantly better (faster) during the latter two-thirds of the hour than they had at first. Also, the music group performed significantly better in the middle third of the hour than during the last third. Other tests, comparing the groups with each other, rather than with themselves, did not demonstrate significant differences with the number of subjects used.

3. The discussion includes a critique of the design used in this exploratory study, with recommendations for future studies.

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Technical Memorandum 16-63 AMCMS Code 5014.11.841

This study draws together two sorts of work -- attempts to improve vigilance performance and use of background music in industrial settings -- to explore how background music affects performance on a vigilance task. Fourteen subjects were tested on a simple disjunctive reaction time task, which gave eight stimuli in an hour's session. The independent variable was music (a specially programmed Muzak tape recording) vs. continuous noise (a small fan in the experimental room). The performance of subjects who worked while hearing noise did not change significantly during the hour. However, the subjects who heard background music responded significantly better (faster) during the latter two-thirds of the hour than they had at first. Also, the music group performed significantly better in the middle third of the hour than during the last third. Other tests, comparing the groups with each other, rather than with themselves, did not demonstrate significant differences with the number of subjects used.

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